SHORT EARS AN AUTOSOMAL MUTATION IN THE HOUSE MOUSE[1]

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Introduction

Although the house mouse has been one of the favorite mammals used for the collection of Mendelian data, the number of known loci falls far short of the number of chromosomes observed in the germ cells of this species. Therefore, any addition to the list of Mendelian characters in this form should be a matter of interest to the geneticist.

For several years, mice with unusually small ears have been known to exist, but, I believe, no description of the variation has been reported in the literature. The sterility exhibited by many of the individuals used in the following experiments has hindered the collection of data so that the amount is not large, but it has seemed advisable to put on record the results thus far obtained.

The data are based upon observations made at the earliest stage at which it was possible to distinguish with accuracy between the long- and short-eared types. Depletion of litters occurring previous to that time was disregarded.

Description of the Character

The mutation was found in stock which originally came from the Lathrop mouse farm and consists in a noticeable difference in the size of the ear. The pinna is about one half as long as that of the normal ear and usually one or two millimeters less broad but the position in which it is held lying close to the head makes it appear smaller than it actually is. In outline it is less regularly curved than the normal, a flattening near the tip of the ear and one in

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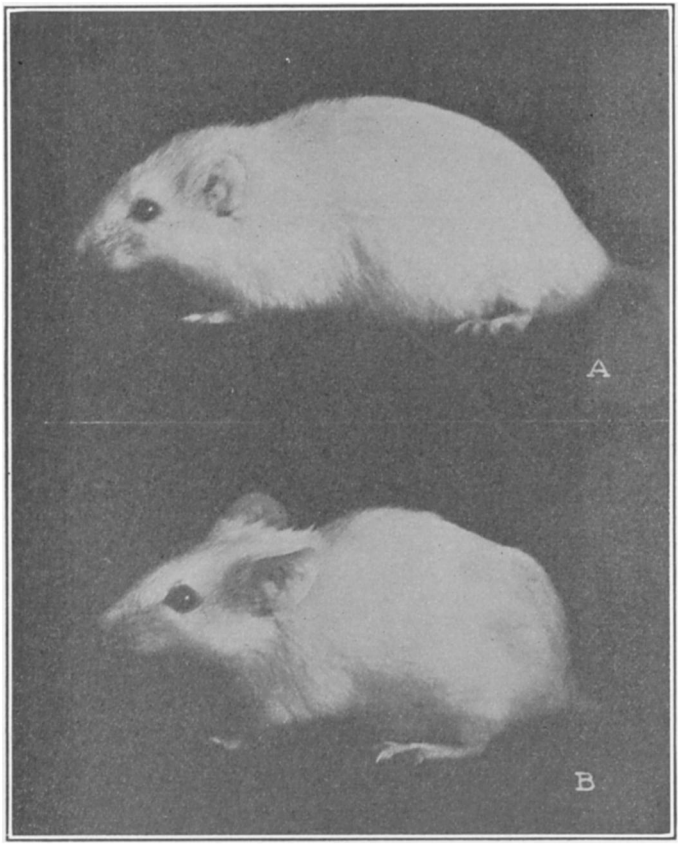

A. Mouse showing the mutation "short ears."
B. An F_1 hybrid from a cross between a short-eared and a long-eared mouse. Ears similar to normal.

the outer margin being fairly constant features. It is usually thick and rather fleshy in appearance. The distribution of hair on the surface of the ear is similar to the normal.

EXPERIMENTAL INVESTIGATION

The Mutant Out-crossed.—The first two experiments showed immediately that the character "short ears" is recessive and that it is not sex-linked. Seven crosses were made between short-eared males and a number of long-eared females which were taken from sources other than the Lathrop stock or from Lathrop strains which

had never been known to produce any short-eared mice. In the F_1 there appeared seventeen young of which ten were males and seven females (Table I). The ears of all

TABLE I

SHORT-EARED MALES CROSSED TO LONG-EARED FEMALES

Mating	F_1 Long	
	♂ ♂	♀ ♀
178	1	1
1369–1	1	1
1369–2	2	0
1369–3	2	0
1443–b	2	2
1443–d1	1	2
1443–d2	1	1
Total	10	7

these mice were long—in fact, indistinguishable from the ears of normal mice. In the reciprocal cross, where the male parent was long-eared and the female short, the offspring were again all long-eared and also comprised members of both sexes. The numbers obtained in the second case (mating 1790, 1 male and 2 females) are very small, partly owing to an unusual amount of destruction of the young which happened to occur in this type of cross, but they indicate that sex-linkage is not involved. Were the gene for short ears located in the sex chromosome, "criss-cross" inheritance would result from this mating and the sons would resemble the female parent and the daughters would be like the male parent since the sons would receive their single X chromosome carrying the short-ear gene from their short-eared mother, while the daughters would receive one X containing the short-ear gene from the mother, and the other X carrying the dominant long-ear gene from the father. This event was not realized—both sexes were of the same type, showing that both kinds of sperm formed by the long-eared father, whether they were male-producing or female-producing, carried the normal allelomorph of the gene for short ears and determined the appearance of the

long-eared F_1 individuals. Since it occurred in both types of sperm the short-ear gene must be located in one of the autosomes.

The Back-cross.—The back-cross between long-eared mice, heterozygous for short ears and short-eared mice, gave 51 long-eared animals to 43 with short ears (the sums of the figures in Tables II and III). On the assump-

TABLE II

BACK-CROSS. HETEROZYGOUS F_1 MALES CROSSED TO SHORT-EARED FEMALES

Mating	Long			Short		
	♂♂	♀♀	Sex Not Recorded	♂♂	♀♀	Sex Not Recorded
1612–RF	1	3				
1612–HT				3	1	
1654–a	2	1		2	1	
1654–2			3			
1656–B	3					
1656–1		1		3		
1656–2			1			1
1656–T	1	1				
1656–RH			2			
1656	3	1				
1655						3
	10	7	6	8	2	4
Total	23			14		

tion that the character is due to one gene, the expected back-cross ratio is 1 : 1. In a total of 94, the expectation for the two classes would be 47 : 47. The actual numbers obtained fit the calculated sufficiently well to justify the conclusion that short ears depend upon a single pair of genes.

In conformity with the results of the first test, the back-cross also shows that there is no sex-linkage concerned in the transmission of the new character. The long-eared F_1 males (obtained by crossing normal females with short-eared males) were bred to short-eared females. If the new gene were sex-linked, the F_1 male would have but one "dose" of the allelomorph long ears. It would be

TABLE III

BACK-CROSS. HETEROZYGOUS F_1 FEMALES CROSSED TO SHORT-EARED MALES

Mating	Long			Short		
	♂♂	♀♀	Sex Not Recorded	♂♂	♀♀	Sex Not Recorded
1655b–1	.....	.....	.....	2	3	
1655a–1	1	2	.....	1	2	
1655b–2	.....	2	.....	.....	1	
1655a–2	1	1	.....	1	3	
1655a1–1	2	3	.....	1		
1655b–3	1	1	.....	2	1	
1655a1–2	1	1	.....	1		
1655	.....	.....	2	.....	.....	3
1719–1	1	3	.....	1	1	1
1719–2	3	.....	.....	.....	1	
1758	1	1	1	1	1	2
	11	14	3	10	13	6
Total	28			29		

carried by the single X chromosome and distributed only to his daughters, which would have long ears. His sons would not receive it; therefore they all would be short-eared like the maternal parent.

The offspring from this cross are listed in Table II. In a few cases the mice escaped or were destroyed by the parents before the sex was recorded. There were, in ad-

TABLE IV

HETEROZYGOUS LONG-EARED MALES BY HETEROZYGOUS LONG-EARED FEMALES

Mating	Long	Short
1655–5	4	1
1723–2	2	4
863	3	
1758–2	2	1
Total	11	6

TABLE V

SHORT-EARED MALES BY SHORT-EARED FEMALES

Mating	Short ♂ ♂	Short ♀ ♀
1443–1	4	
1727–1	3	2
1727–2	1	3
Total	8	5

dition, ten males and seven females which had long ears and eight males and two females with short ears. The appearance of individuals of each sex in each class shows that the gene must not be carried by the X chromosome.

The First Filial Generation Inbred.—A very small number of mice were obtained from inbreeding the long-eared heterozygous F_1 offspring. These gave, in the F_2, 11 long to 6 short (Table IV). In a total of 17 individuals on a one-factor basis, the numbers calculated for a 3:1 ratio would be 12.75 to 4.25. The results are consistent with our previous conclusion as to the number of genes involved.

The Inbred Recessive.—The test of the inbred recessive demonstrates that the character breeds true. Three matings between short-eared males and females have yielded 13 young, all with short ears (Table V).

CONCLUSION

The data given above show that the mutation "short ears" which appears as a perfectly definite and easily distinguishable character in mice behaves as a recessive and is dependent upon a single gene which is not sex-linked. Other possible linkage relationships have not yet been worked out.